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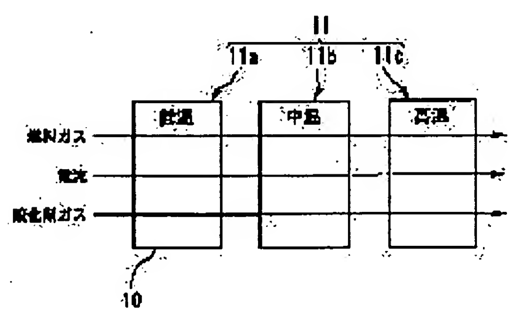
(54) FUEL CELL SYSTEM

(57)Abstract:

PROBLEM TO BE SOLVED: To accelerate reaction and increasing the battery cell output by successively relatively raising the operation temperature of cell stacks connected in series in the flow direction of reaction gas, and moistening the reaction gas according to the operating temperature of the cell stack flowing at first, then supplying the moistened reaction gas.



SOLUTION: A fuel cell system is constituted with cell stacks 11a, 11b, 11c for operating at low, middle, and high temperatures, fuel gas and oxidizing agent gas let continuously flow from the low temperature side to the high temperature side. The fuel gas and the oxidizing agent gas are previously moistened by adding water vapor, and the temperature of a reaction gas is raised so as to correspond to the operation temperature of each cell stack. Even if the non-reacted part of the reaction gas is increased in the cell stack 11a for operating at low temperature, the non-reacted gas is reacted and completely consumed in the cell stacks 11b, 11c for operating at the intermediate and high temperatures. Even if condensed water generating on a carbon electrode side of the cell stack 11a is increased, the water is evaporated in the cell stacks 11b, 11c, and the reaction of the oxidizing agent gas is conducted smoothly.

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CLAIMS

[Claim(s)]
[Claim 1] The cell stack which accumulated and constituted the unit cell equipped with the separator which made the anode electrode and the cathode electrode infix in both sides on both sides of the solid-state polyelectrolyte film is connected to series. While elevated-temperature-izing relatively [flow direction / of said reactant gas] one by one the operating temperature of the cell stack connected to the cell stack linked to these series at said series in the fuel cell equipment which comes to supply reactant gas at series Fuel cell equipment characterized by humidifying said reactant gas beforehand and supplying it corresponding to the operating temperature of the cell stack passed first..
[Claim 2] The cell stack which accumulated and constituted the unit cell equipped with the separator which made the anode electrode and the cathode electrode infix in both sides on both sides of the solid-state polyelectrolyte film is connected to series. While elevated-temperature-izing relatively [flow direction / of said reactant gas] one by one the operating temperature of the cell stack connected to the cell stack linked to these series at said series in the fuel cell equipment which comes to supply reactant gas at series Fuel cell equipment characterized by having a cooling-medium supply means to pour a cooling medium in the same direction as the flow direction of said reactant gas while humidifying said reactant gas beforehand and supplying it corresponding to the operating temperature of the cell stack passed first.
[Claim 3] Fuel cell equipment according to claim 1 or 2 characterized by dividing the cell stack linked to series one by one along the flow direction of reactant gas to the object for low-temperature operation, the object for moderate temperature operation, and each cell stack for elevated-temperature operation.
[Claim 4] The cell stack which accumulated and constituted the unit cell equipped with the separator which made the anode electrode and the cathode electrode infix in both sides on both sides of the solid-state polyelectrolyte film is connected to series. While elevated-temperature-izing relatively [flow direction / of said reactant gas] one by one the operating temperature of the cell stack connected to the cell stack linked to these series at said series in the fuel cell equipment which comes to supply reactant gas at series Said at least one or more cell stacks elevated-temperature-ized relatively one by one Fuel cell equipment characterized by humidifying said reactant gas beforehand and supplying it corresponding to the operating temperature of the sub cell stack passed first while dividing to the sub cell stack elevated-temperature-ized still more relatively [flow direction / of said reactant gas] one by one.
[Claim 5] Fuel cell equipment according to claim 4 characterized by dividing the sub cell stack which divided at least one or more cell stacks one by one along the flow direction of reactant gas to the object for low-temperature operation, the object for moderate temperature operation, and each sub cell stack for elevated-temperature operation.
[Claim 6] Fuel cell equipment according to claim 1, 2, or 4 characterized by forming relatively small the opening area of the downstream of the reactant gas supply slot formed in a separator compared with the opening area of the upstream of said reactant gas supply slot.
[Claim 7] The cell stack which accumulated and constituted the unit cell equipped with the separator which made the anode electrode and the cathode electrode infix in both sides on both sides of the solid-state polyelectrolyte film is connected to series. While elevated-temperature-izing relatively [flow direction / of said reactant gas] one by one the operating temperature of the cell stack connected to the cell stack linked to these series at said series in the fuel cell equipment which comes to supply reactant gas at series Fuel cell equipment characterized by having the means which flows said reactant gas passed to said cell stack elevated-temperature-

ized relatively one by one in any direction of the forward direction and hard flow while humidifying said reactant gas beforehand and supplying it corresponding to the operating temperature of the cell stack passed first.
[Claim 8] The cell stack which accumulated and constituted the unit cell equipped with the separator which made the anode electrode and the cathode electrode infix in both sides on both sides of the solid-state polyelectrolyte film is connected to series. While elevated-temperature-izing relatively [flow direction / of said reactant gas] one by one the operating temperature of the cell stack connected to the cell stack linked to these series at said series in the fuel cell equipment which comes to supply reactant gas at series Said at least one or more cell stacks elevated-temperature-ized relatively one by one It divides to the sub cell stack elevated-temperature-ized still more relatively [flow direction / of said reactant gas] one by one. Fuel cell equipment characterized by having a cooling-medium supply means to pour a cooling medium in series in the same direction as the flow direction of said reactant gas while humidifying said reactant gas beforehand and supplying it corresponding to the operating temperature of the sub cell stack passed first.
[Claim 9] The fuel cell equipment characterized by to equip with a header the both sides of the reactant-gas supply slot which forms in the cell stack which connected to series the cell stack which accumulated and constituted the unit cell equipped with the separator which made the anode electrode and the cathode electrode infix in both sides on both sides of the solid-state polyelectrolyte film , and was connected to these series at said separator in the fuel cell equipment which comes to supply reactant gas at series .
[Claim 10] Fuel cell equipment according to claim 9 characterized by equipping the pars basilaris ossis occipitalis of a header with a manifold.
[Claim 11] The cell stack which accumulated and constituted the unit cell equipped with the separator which made the anode electrode and the cathode electrode infix in both sides on both sides of the solid-state polyelectrolyte film is connected to series. While elevated-temperature-izing relatively [flow direction / of said reactant gas] one by one the operating temperature of the cell stack connected to the cell stack linked to these series at said series in the fuel cell equipment which comes to supply reactant gas at series A means to make the reactant gas supplied to said first cell stack humidify, and the cooling-medium feeder which makes the cell stack which connected to said series and was elevated-temperature-ized relatively one by one circulate through a cooling medium, Fuel cell equipment characterized by having the control system which drives the cooling-medium feeder which makes the cell stack which connected to said series and was elevated-temperature-ized relatively one by one circulate through a cooling medium.
[Claim 12] Fuel cell equipment according to claim 11 characterized by constituting a cooling-medium feeder combining a condensator, a tank, and a circulating pump.
[Claim 13] Fuel cell equipment according to claim 11 characterized by equipping a control system with the control operation part which drives or stops the cooling-medium feeder which connects with series, calculates an operating temperature based on a signal whenever [one signal / of the dew point temperature of a cell stack and humidity which were elevated-temperature-ized relatively one by one /, and vessel internal temperature / of said electric stack] to the flow direction of reactant gas, and supplies a cooling medium to said cell stack.
[Claim 14] Fuel cell equipment according to claim 11 characterized by having the control operation part which drives or stops the cooling-medium feeder which connects with series, calculates to a control system based on a signal whenever [signal / of the internal resistance value of the unit cell which constitutes the cell stack which elevated-temperature-ized the operating temperature relatively one by one to the flow direction of reactant gas /, and vessel internal temperature / of said cell stack], and supplies a cooling medium to said cell stack.
[Claim 15] Fuel cell equipment according to claim 11 characterized by equipping a control system with the control operation part which drives or stops the cooling-medium feeder which connects with the humidity signal of reactant gas, and series, calculates based on a signal whenever [current signal / which generates an operating temperature in the flow direction of reactant gas at the cell stack elevated-temperature-ized relatively one by one /, and vessel internal temperature], and supplies a cooling medium to said cell stack.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to fuel cell equipment using the solid-state poly membrane equipped with ion conductivity as an electrolyte.
[0002]
[Description of the Prior Art] There is a thing of some form in fuel cell equipment according to an electrolytic class. the inside of these -- as an electrolyte -- ion -- a conductor -- in respect of the solid-state macromolecule electrolytic type fuel cell equipment using the solid-state poly membrane equipped with the sex having high power density, and structure being comparatively made as for it to a compact etc., it is observed recently and there are some which are shown in drawing 10 as the configuration.
[0003] While this solid-state polyelectrolyte mold fuel cell equipment constitutes the unit cell (unit cell) 4 which equipped both sides with the anode electrode (fuel electrode) 2 and the cathode electrode (oxidizer pole) 3 on both sides of the solid-state polyelectrolyte film 1 arranged in that center It has fuel gas supply slot 5a and oxidant gas supply slot 5b which divide into each electrodes 2 and 3 and supply each of the oxygen in fuel gas, for example, hydrogen, and oxidant gas, for example, air, through 6a and 7a, and has the composition of having excelled in conductivity and having formed the impermeable separators 6 and 7.
[0004] While forming the anode electrode 2 with anode catalyst bed 2a and anode porosity carbon monotonous 2b, the cathode electrode 3 is formed by cathode catalyst bed 3a and cathode porosity carbon plate 3b.
[0005] In solid-state polyelectrolyte mold fuel cell equipment equipped with such a configuration, if fuel gas is supplied to the anode electrode 2 side and oxidant gas is supplied to the cathode electrode 3 side, the unit cell 4 will react chemically and will generate a current. That is, anode catalyst bed 2a makes an external circuit (not shown) generate a sink and a current for an electron, if fuel gas is supplied to the anode electrode 2 side while pouring the hydrogen ion which was made to divide fuel gas into a hydrogen ion and an electron, and was separated to the solid-state poly membrane 1.
[0006] Moreover, if oxidant gas is supplied to the cathode electrode 3 side, cathode catalyst bed 3a will make the electron from the above-mentioned hydrogen ion and above-mentioned external circuit from the solid-state polyelectrolyte film 1 react to oxidant gas, especially oxygen, and will generate the water of condensation. The reaction formula by the side of the anode electrode 2 and the cathode electrode 3 is expressed with a degree type, respectively in that case.
[0007]
[Formula 1]

アノード電極側 : $H_2 \rightarrow 2H^+ + 2e^-$

カソード電極側 : $2H^+ + \frac{1}{2}O_2 + 2e^- \rightarrow H_2O$

[0008] In addition, the water of condensation generated by the cathode electrode 3 side is emitted out of a vessel from the unit cell 4 with a unconverted gas.
[0009] Thus, although the unit cell 4 makes fuel gas and oxidant gas react and is generating electromotive force, since the electromotive force to generate is less than [1V], usually it makes the unit cell 4 dozens - 100 numbers, accumulates it in the direction of a vertical, and constitutes the cell stack 8 from solid-state

polyelectrolyte mold fuel cell equipment.
[0010] On the other hand, the park RUORORO carbon sulfonic acid (trade name: Nafion, the U.S. Du Pont make) which produces the solid-state polyelectrolyte film 1 applied as an electrolyte for example, on the proton exchange film is used. This solid-state polyelectrolyte film 1 has the exchange group of a hydrogen ion in a molecule, and has a function good as ion conductivity by holding saturated water.
[0011] By the way, in order to generate the still higher electromotive force from the cell stack 8, and to secure conjointly good ion conductivity with development of the solid-state poly membrane 1, making saturated water always hold is needed for the solid-state polyelectrolyte film 1. Moreover, if the water of condensation generated by the cathode electrode 3 side is left as it is, since the reaction of the cathode electrode 3 will worsen, removal of the water of condensation is needed.
[0012] Even if easily solvable if the steam near operational status is beforehand added to reactant gas (both fuel gas and oxidant gas) and is humidified in order to make saturated water always hold on the solid-state polyelectrolyte film 1, that structure is also complicated helps, development is difficult, and a means to remove the water of condensation generated at the cathode electrode 3 side is under grope now.
[0013]
[Problem(s) to be Solved by the Invention] Recently as a means to remove the water of condensation generated at the cathode electrode 3 side Form fuel gas supply slot 5a of separators 6 and 7 and oxidant gas supply slot 5b which supply reactant gas in the shape of Serpentine, or Opening area of fuel gas supply slot 5a and oxidant gas supply slot 5b is made small, a gas flow rate is raised, and invention which blows away the water of condensation besides a vessel using the rate energy is released (U.S. patent USP-4,988,583, USP-5,108,849).
[0014] However, in order to raise a gas flow rate, when opening area of fuel gas supply slot 5a of separators 6 and 7 and oxidant gas supply slot 5b was made small, the number of each slots 5a and 5b increased further, the production man day also increased, and there was a trouble that the cost which produces the cell stack 8 became much more expensive.
[0015] When opening area of fuel gas supply slot 5a of separators 6 and 7 and oxidant gas supply slot 5b is made small, moreover, the water of condensation collected in the each slot 5a and 5b Even if it could blow away besides the vessel, the water of condensation generated by cathode catalyst bed 3a needed to be again put back to each of those slots 5a and 5b through cathode porosity carbon plate 3b, and had the trouble that the water of condensation was certainly unremovable only by raising a gas flow rate.
[0016] Moreover, in order to have blown away besides the vessel the water of condensation brought together in fuel gas supply slot 5a and oxidant gas supply slot 5b, reactant gas needed to be high-pressure-ized, only the part which made reactant gas high-pressure-ize consumed many energy, and there were fault, such as becoming the factor which reduces plant thermal efficiency rather, and un-arranging on a sankey diagram as a result.
[0017] Moreover, when fuel gas supply slot 5a and oxidant gas supply slot 5b were formed in the shape of Serpentine, there was a trouble that the pressure loss of reactant gas made increase and consequent more much reactant gas consume.
[0018] This invention coped with such a trouble, was made, makes the water of condensation generated by the cathode electrode side remove certainly, and aims at offering the fuel cell equipment which was made to promote the reaction of fuel gas and oxidant gas further, and attained high cell output-ization.
[0019]
[Means for Solving the Problem] In order to attain the above-mentioned purpose, as indicated to claim 1, the fuel cell equipment concerning this invention The cell stack which accumulated and constituted the unit cell equipped with the separator which made the anode electrode and the cathode electrode infix in both sides on both sides of the solid-state polyelectrolyte film is connected to series. While elevated-temperature-izing relatively [flow direction / of said reactant gas] one by one the operating temperature of the cell stack connected to the cell stack linked to these series at said series in the fuel cell equipment which comes to supply reactant gas at series Corresponding to the operating temperature of the cell stack passed first, said reactant gas is humidified beforehand and supplied.
[0020] Moreover, in order to attain the above-mentioned purpose, as indicated to claim 2, the fuel cell equipment concerning this invention The cell stack which accumulated and constituted the unit cell equipped with the separator which made the anode electrode and the cathode electrode infix in both sides on both sides of the solid-state polyelectrolyte film is connected to series. While elevated-temperature-izing relatively [flow

direction / of said reactant gas] one by one the operating temperature of the cell stack connected to the cell stack linked to these series at said series in the fuel cell equipment which comes to supply reactant gas at series While humidifying said reactant gas beforehand and supplying it corresponding to the operating temperature of the cell stack passed first, it has a cooling-medium supply means to pour a cooling medium in the same direction as the flow direction of said reactant gas.
[0021] Moreover, in order to attain the above-mentioned purpose, the fuel cell equipment concerning this invention divides the cell stack linked to series one by one along the flow direction of reactant gas to the object for low-temperature operation, the object for moderate temperature operation, and each cell stack for elevated-temperature operation, as indicated to claim 3.
[0022] Moreover, in order to attain the above-mentioned purpose, as indicated to claim 4, the fuel cell equipment concerning this invention The cell stack which accumulated and constituted the unit cell equipped with the separator which made the anode electrode and the cathode electrode infix in both sides on both sides of the solid-state polyelectrolyte film is connected to series. While elevated-temperature-izing relatively [flow direction / of said reactant gas] one by one the operating temperature of the cell stack connected to the cell stack linked to these series at said series in the fuel cell equipment which comes to supply reactant gas at series While dividing at least one or more cell stacks elevated-temperature-ized on said sequential relative target to the sub cell stack elevated-temperature-ized still more relatively [flow direction / of said reactant gas] one by one, corresponding to the operating temperature of the sub cell stack passed first, said reactant gas is humidified beforehand and supplied.
[0023] Moreover, in order to attain the above-mentioned purpose, the fuel cell equipment concerning this invention divides the sub cell stack which divided at least one or more cell stacks one by one along the flow direction of reactant gas to the object for low-temperature operation, the object for moderate temperature operation, and each sub cell stack for elevated-temperature operation, as indicated to claim 5.
[0024] Moreover, in order to attain the above-mentioned purpose, the fuel cell equipment concerning this invention forms relatively small the opening area of the downstream of the reactant gas supply slot formed in a separator compared with the opening area of the upstream of said reactant gas supply slot, as indicated to claim 6.
[0025] Moreover, in order to attain the above-mentioned purpose, as indicated to claim 7, the fuel cell equipment concerning this invention The cell stack which accumulated and constituted the unit cell equipped with the separator which made the anode electrode and the cathode electrode infix in both sides on both sides of the solid-state polyelectrolyte film is connected to series. While elevated-temperature-izing relatively [flow direction / of said reactant gas] one by one the operating temperature of the cell stack connected to the cell stack linked to these series at said series in the fuel cell equipment which comes to supply reactant gas at series While humidifying said reactant gas beforehand and supplying it corresponding to the operating temperature of the cell stack passed first, it has the means which flows said reactant gas passed to said cell stack elevated-temperature-ized relatively one by one in any direction of the forward direction and hard flow.
[0026] Moreover, in order to attain the above-mentioned purpose, as indicated to claim 8, the fuel cell equipment concerning this invention The cell stack which accumulated and constituted the unit cell equipped with the separator which made the anode electrode and the cathode electrode infix in both sides on both sides of the solid-state polyelectrolyte film is connected to series. While elevated-temperature-izing relatively [flow direction / of said reactant gas] one by one the operating temperature of the cell stack connected to the cell stack linked to these series at said series in the fuel cell equipment which comes to supply reactant gas at series Said at least one or more cell stacks elevated-temperature-ized relatively one by one It divides to the sub cell stack elevated-temperature-ized still more relatively [flow direction / of said reactant gas] one by one. While humidifying said reactant gas beforehand and supplying it corresponding to the operating temperature of the sub cell stack passed first, it has a cooling-medium supply means to pour a cooling medium in series in the same direction as the flow direction of said reactant gas.
[0027] Moreover, in order to attain the above-mentioned purpose, as indicated to claim 9, the fuel cell equipment concerning this invention The cell stack which accumulated and constituted the unit cell equipped with the separator which made the anode electrode and the cathode electrode infix in both sides on both sides of the solid-state polyelectrolyte film is connected to series. The both sides of the reactant gas supply slot formed in the cell stack linked to these series at said separator in the fuel cell equipment which comes to supply reactant

gas at series are equipped with a header.
[0028] Moreover, in order to attain the above-mentioned purpose, the fuel cell equipment concerning this invention equips the pars basilaris ossis occipitalis of a header with a manifold, as indicated to claim 10.
[0029] Moreover, in order to attain the above-mentioned purpose, as indicated to claim 11, the fuel cell equipment concerning this invention The cell stack which accumulated and constituted the unit cell equipped with the separator which made the anode electrode and the cathode electrode infix in both sides on both sides of the solid-state polyelectrolyte film is connected to series. While elevated-temperature-izing relatively [flow direction / of said reactant gas] one by one the operating temperature of the cell stack connected to the cell stack linked to these series at said series in the fuel cell equipment which comes to supply reactant gas at series A means to make the reactant gas supplied to said first cell stack humidify, and the cooling-medium feeder which makes the cell stack which connected to said series and was elevated-temperature-ized relatively one by one circulate through a cooling medium, It connects with said series and has the control system which drives the cooling-medium feeder which makes the cell stack elevated-temperature-ized relatively one by one circulate through a cooling medium.
[0030] Moreover, in order to attain the above-mentioned purpose, the fuel cell equipment concerning this invention constitutes a cooling-medium feeder combining a condensator, a tank, and a circulating pump, as indicated to claim 12.
[0031] Moreover, in order to attain the above-mentioned purpose, as indicated to claim 13, it connects with series, and the fuel cell equipment concerning this invention calculates an operating temperature based on a signal whenever [one signal / of the dew point temperature of a cell stack and the humidity elevated-temperature-ized relatively one by one / and vessel internal temperature / of said electric stack] to the flow direction of reactant gas, and equips a control system with the control operation part which drives or stops the cooling-medium feeder which supplies a cooling medium to said cell stack.
[0032] Moreover, in order to attain the above-mentioned purpose, as indicated to claim 14, the fuel cell equipment concerning this invention The signal of the internal resistance value of the unit cell which constitutes the cell stack which connected with series and elevated-temperature-ized the operating temperature relatively one by one to the control system in the flow direction of reactant gas, Based on a signal, it calculates whenever [vessel internal temperature / of said cell stack], and has the control operation part which drives or stops the cooling-medium feeder which supplies a cooling medium to said cell stack.
[0033] Moreover, in order to attain the above-mentioned purpose, as indicated to claim 15, it connects with the humidity signal of reactant gas, and series, and the fuel cell equipment concerning this invention is calculated based on a signal whenever [current signal / which generates an operating temperature in the flow direction of reactant gas at the cell stack elevated-temperature-ized relatively one by one /, and vessel internal temperature], and equips a control system with the control operation part which drives or stops the cooling-medium feeder which supplies a cooling medium to said cell stack.
[0034]
[Embodiment of the Invention] It explains using the sign which attached the operation gestalt of the fuel cell equipment concerning this invention all over a drawing and drawing hereafter.
[0035] Drawing 1 is the mimetic diagram showing the 1st operation gestalt of the fuel cell equipment concerning this invention.
[0036] The fuel cell equipment concerning this operation gestalt is effective area 169cm 2 The plate-like unit cell (unit cell) 10 to carry out It is made ten sheets, puts in the direction of a vertical, and the cell stack 11 is constituted. The cell stack 11 For example, while dividing to cell stack 11for low-temperature operation a, cell stack 11for moderate temperature operation b, and cell stack 11c for elevated-temperature operation and connecting electrically It is made the configuration which passes fuel gas and oxidant gas continuously toward cell stack 11c for elevated-temperature operation from cell stack 11for low-temperature operation a among the cell stacks 11a, 11b, and 11c for elevated-temperature operation into each low one. In addition, with this operation gestalt, each operating temperature of the cell stacks 11a, 11b, and 11 for elevated-temperature operation is set as 50 degrees C, 60 degrees C, and 65 degrees C into low. A steam is beforehand added and humidified into low to the fuel gas and oxidant gas which are supplied to the cell stacks 11a, 11b, and 11c for elevated-temperature operation, and into low, humidity of above-mentioned reactant gas is made high so that the operating temperature of the cell stacks 11a, 11b, and 11c for elevated-temperature operation may be

balanced.
[0037] Moreover, when reactant gas (both fuel gas and oxidant gas) flows toward cell stack 11c for elevated-temperature operation one by one from cell stack 11for low-temperature operation a, Since the diffusion rate of as opposed to [reaction specific consumption (utilization factor) is high at the upstream, and reaction specific consumption is low at the downstream, and] the anode electrode side of reactant gas and a cathode electrode side becomes low, with this operation gestalt Opening area of the fuel gas supply slot of the downstream and an oxidizer supply slot (not shown [both]) is relatively made small compared with it of the upstream, and it has the composition of raising the rate of flow of reactant gas and making reaction effectiveness equalizing. Both a fuel gas supply slot and an oxidizing agent gas supply slot make a pitch the same, and, specifically, have formed the depth ratio in 4:3:1 into low to the cell stacks 11a, 11b, and 11c for elevated-temperature operation.
[0038] With this operation gestalt equipped with such a configuration, as a result of being test operation, as for 400mA (utilization factor)/cm of reaction specific consumption of oxidant gas, 2 and the reaction specific consumption (utilization factor) of fuel gas became 50% 80%, and cell output operation time of a load current consistency improved in 3000 hours compared with the former.
[0039] Moreover, with this operation gestalt, since the cell stack 11 was divided into low to the cell stacks 11a, 11b, and 11c for elevated-temperature operation, compared with one cell stack which sets an operating temperature constant, the average electrical potential difference increased 5% like before, and having generated the stable cell output with little fluctuation distribution moreover was admitted.
[0040] Thus, with this operation gestalt, the cell stack 11 is divided into low to each of the cell stacks 11a, 11b, and 11c for elevated-temperature operation. Since reactant gas was made the configuration which passes to continuation toward cell stack 11c for elevated-temperature operation one by one from cell stack 11for low-temperature operation a while carrying out series connection of the cell stacks 11a, 11b, and 11c for elevated-temperature operation electrically into low [which was divided] The stable cell output can be generated and the reaction specific consumption (utilization factor) of reactant gas can be raised further.
[0041] That is, since reactant gas is passed to continuation one by one into low at the cell stacks 11a, 11b, and 11c for elevated-temperature operation, even if the unreacted part of reactant gas increases comparatively, for example in cell stack 11a for low-temperature operation, it can be made to be able to react by the next object for moderate temperature operation, or the cell stacks 11b and 11c for elevated-temperature operation, and it can be made to consume without the place which leaves reactant gas.
[0042] Moreover, with this operation gestalt, since opening area of the fuel gas supply slot on the downstream and an oxidant gas supply slot was relatively made small compared with it of the upstream and the rate of flow of reactant gas was raised, equalization of reaction effectiveness can be attained and the stable cell output can be generated.
[0043] Therefore, since the cell output stabilized even if it did not supply reactant gas to each of the cell stacks 11a, 11b, and 11c for elevated-temperature operation superfluously into low can be promoted according to this operation gestalt, the amount of supply of reactant gas can be lessened compared with the former.
[0044] Moreover, with this operation gestalt, since each operating temperature of the cell stacks 11a, 11b, and 11c for elevated-temperature operation was made high one by one in accordance with the flow of reactant gas into low Since it will be made to evaporate in the object for moderate temperature operation of order with a high operating temperature, or the cell stacks 11b and 11c for elevated-temperature operation even if the water of condensation generated increases in number in the case of the reaction of the oxidant gas by the side of the carbon electrode of cell stack 11a for low-temperature operation, oxidant gas can be made to react good. In addition, into low, although you may install separately [each of the cell stacks 11a, 11b, and 11c for elevated-temperature operation] independently, since the possibility of a fault cell output is in a specific cell stack when it installs separately independently, it is desirable to carry out series connection electrically.
[0045] Drawing 2 is the mimetic diagram showing the 2nd operation gestalt of the fuel cell equipment concerning this invention. In addition, the same sign is given to the same as that of the component of the 1st operation gestalt, or a corresponding part.
[0046] The fuel cell equipment concerning this operation gestalt like the 1st operation gestalt the cell stack 11 For example, while dividing into low to the cell stacks 11a, 1b, and 11c for elevated-temperature operation and carrying out series connection of the cell stacks 11a, 11b, and 11c for elevated-temperature operation electrically into low A cooling-medium supply means 12, for example, cooling water piping, to supply a

cooling medium, for example, cooling water, succeeding the cell stacks 11a, 11b, and 11c for elevated-temperature operation is established into low. In addition, the operating temperature of cell stack 11a for low-temperature operation is determined by the temperature of the cooling medium supplied from the cooling-medium supply means 12. Moreover, the operating temperature of cell stack 11c for elevated-temperature operation measures the temperature of the cooling medium discharged from cell stack 11for elevated-temperature operation c, and is determined by adjusting the amount of cooling media. Furthermore, the mean temperature of the operating temperature of cell stack 11a for low-temperature operation and the operating temperature of cell stack 11c for elevated-temperature operation is used for the operating temperature of cell stack 11b for moderate temperature operation.

[0047] Thus, with this operation gestalt, a cooling-medium supply means 12 to continue and supply a cooling medium to the cell stacks 11a, 11b, and 11c for elevated-temperature operation is established into low. Since much more temperature inclination-ization of the cell stacks 11a, 11b, and 11c for elevated-temperature operation was attained into low When making oxidant gas react temporarily by the cathode electrode side of cell stack 11a for low-temperature operation, Even if the water of condensation generated increases in number, promotion of evaporation can be made to be able to ensure by the next object for moderate temperature operation, or the cell stacks 11b and 11c for elevated-temperature operation, and the cell output which raised much more reaction of oxidant gas and was stabilized can be generated.

[0048] Drawing 3 is the mimetic diagram showing the 3rd operation gestalt of the fuel cell equipment concerning this invention. In addition, the same sign is given to the same as that of the component of the 1st operation gestalt, or a corresponding part.

[0049] The inside of low [which showed the fuel cell equipment concerning this operation gestalt with the 1st operation gestalt], inside, and the cell stacks 11a, 11b, and 11c for elevated-temperature operation, It is cell stack 11a for low-temperature operation further Low, inside, the sub cell stack 11a1 for elevated-temperature operation, 11a2, and 11a3 While dividing to each Low, inside, the sub cell stack 11a1 for elevated-temperature operation, 11a2, and 11a3 Series connection is made to carry out in the same direction as the flow direction of reactant gas (both fuel gas and oxidant gas). in addition, inside and the cell stacks 11b and 11c for elevated-temperature operation -- **** -- the same -- the sub cell stack 11b1 for low-temperature operation, 11c1, the sub cell stack 11b2 for moderate temperature operation, 11c2, the sub cell stack 11b3 for elevated-temperature operation, and 11c3 It is divided.

[0050] Generally, as for the cell stack 11, when the independent cell 10 is taken for an example, compared with the outlet side, cell power density has the direction of the entrance side in the inclination which becomes high to a thing with the low reaction specific consumption (utilization factor) of reactant gas.

[0051] With this operation gestalt, it is what noted such a point and divides finely into low into low at the sub cell stack 11a1 for elevated-temperature operation, 11b1, 11c1, 11a2, 11b2, 11c2, and -- to every cell stack 11a and 11b for elevated-temperature operation, and 11c.

[0052] Moreover, low [which was divided into low with this operation gestalt to every cell stack 11a and 11b for elevated-temperature operation, and 11c], The opening area of the fuel gas supply slot which supplies reactant gas (both fuel gas and oxidant gas) to the sub cell stack 11a1 for elevated-temperature operation, 11b1, 11c1, 11a2, 11b2, 11c2, and -- inside, and an oxidant gas supply slot (not shown [both]) Compared with the upstream, the downstream is relatively made small, and it has the composition of raising the fluid of reactant gas and making reaction effectiveness equalizing. Like the 1st operation gestalt, a pitch is made the same and the depth ratio is specifically [both] formed in 4:3:1 into low to the sub cell stack 11a1 for elevated-temperature operation, 11b1, 11c1, 11a2, 11b2, 11c2, and --.

[0053] With this operation gestalt, thus, into low to every cell stack 11a and 11b for elevated-temperature operation, and 11c Into low, since it divided finely with the sub cell stack 11a1 for elevated-temperature operation, 11b1, 11c1, 11a2, 11b2, 11c2, and --, the stable cell output without the unevenness from the cell stacks 11a, 11b, and 11c for elevated-temperature operation can be generated into low.

[0054] With this operation gestalt, moreover, into low to every cell stack 11a and 11b for elevated-temperature operation, and 11c Since it divided finely into low with the sub cell stack 11a1 for elevated-temperature operation, 11b1, 11c1, 11a2, 11b2, 11c2, and -- In the case of the reaction of oxidant gas, the water of condensation generated can be evaporated further and the reaction of oxidant gas can be promoted good.

[0055] Moreover, with this operation gestalt, since opening area of the fuel gas supply slot on the downstream

and an oxidant gas supply slot was relatively made small compared with it of the upstream and the rate of flow of reactant gas was raised, much more equalization of reaction high rate can be attained, and the stable cell output can be generated.
[0056] Drawing 4 is the mimetic diagram showing the 4th operation gestalt of the fuel cell equipment concerning this invention. In addition, the same sign is given to the same part as a component or the corresponding part of the 1st operation gestalt.
[0057] Like the 1st operation gestalt, while dividing the fuel cell equipment concerning this operation gestalt into low to the cell stacks 11a, 11b, and 11c for elevated-temperature operation, the cell stack 11 The reactant gas currently supplied to the cell stacks 11b and 11c for elevated-temperature operation is made the configuration which supplies hard flow inside one by one from cell stack 11for low-temperature operation a after the operation-time progress which was able to be defined beforehand. The bulb (not shown) installed in piping is specifically changed, and it is carried out by passing reactant gas to the flow direction and hard flow of illustration. In addition, the operating method which passes reactant gas to hard flow after the operation-time progress which was able to be defined beforehand is applied also to the 3rd operation gestalt shown by drawing 3 .
[0058] Thus, with this operation gestalt, since reactant gas was made the configuration which passes to hard flow after the operation-time progress which was able to be defined beforehand, the fall of the cell property of the cell stacks 11a, 11b, and 11c for elevated-temperature operation can be low suppressed into low, and generating of the stable cell output can be maintained for a long time.
[0059] Drawing 5 is the mimetic diagram showing the 5th operation gestalt of the fuel cell equipment concerning this invention. In addition, the same sign is given to the same as that of the component of the 1st operation gestalt, the 2nd operation gestalt, and the 3rd operation gestalt, or a corresponding part.
[0060] The fuel cell equipment concerning this operation gestalt is what combined the 2nd operation gestalt and the 3rd operation gestalt with the 1st operation gestalt. While dividing the sub cell stack 11a1 for elevated-temperature operation, 11b1, 11c1, 11a2, 11b2, 11c2, and -- into low into low to every cell stack 11a and 11b for elevated-temperature operation, and 11c A cooling supply means 12 to pour a cooling medium is established in the same direction as the flow direction of reactant gas.
[0061] With this operation gestalt, the sub cell stack 11a1 for elevated-temperature operation, 11b1, 11c1, 11a2, 11b2, 11c2, and a cooling-medium supply means 12 of -- to continue and supply a cooling medium in the same direction as the flow direction of reactant gas are established into low. Thus, low, inside, Since the sub cell stack 11a1 for elevated-temperature operation, 11b1, 11c1, 11a2, 11b2, 11c2, and much more temperature inclination-ization of -- were attained Evaporation of the water of condensation of each sub cell stack 11a1, 11b1, 11c1, 11a2, 11b2, 11c2, and -- generated by the carbon-electrode side can be promoted further, and the stable cell output can be generated.
[0062] Drawing 6 is the schematic diagram showing the operation gestalt of the separator applied to the fuel cell equipment concerning this invention.
[0063] The separator 13 concerning this operation gestalt forms the inlet-port head 15 equipped with inlet-port manifold 15a, and the outlet header 16 equipped with outlet manifold 16a in the both ends of the reactant gas supply slot 14 while forming two or more reactant gas supply slots 14 which supply reactant gas along the direction of a vertical.
[0064] Thus, with this operation gestalt, since the inlet-port header 15 and the outlet header 16 are formed in the both ends of the reactant gas supply slot 14 of a separator 13 and more reactant gas is supplied to them, a still higher cell output can be generated compared with the former.
[0065] Moreover, with this operation gestalt, without being able to process more water of condensation generated from reactant gas, and making the structure of the reactant gas supply slot 14, and a configuration complicate like before, since the both ends of the reactant gas supply slot 14 were equipped with the inlet-port header 15 and the outlet header 16, the production man day time amount can be lessened, and it can contribute to cost reduction. In addition, since this operation gestalt equips the pars-basilaris-ossis-occipitalis side of the inlet-port header 15 and the outlet header 16 with the manifolds 15a and 16a of an inlet port and an outlet, it can change the feeding-and-discarding outlet of reactant gas freely.
[0066] Drawing 7 is the outline control schematic diagram showing the operation gestalt which controls the operating temperature of the cell stack applied to the fuel cell equipment concerning this invention. In addition,

the same sign is given to the same part as the component of the 1st operation gestalt.
[0067] The cell stack 11 concerning this operation gestalt is effective area 169cm 2 It has the composition of having made the plate-like unit cell (unit cell) 10 to carry out into 30 sheets, and having accumulated it in the direction of a vertical.
[0068] This cell stack 11 is equipped with the humidifiers 17a and 17b which make that entrance side humidify fuel gas and oxidant gas, and the dew-point instrument 18 which measures the humidity of oxidant gas to that outlet side. In addition, a dew-point instrument 18 is good at a hygrometer.
[0069] Moreover, the cell stack 11 has composition equipped with the cooling-medium feeder 22 which combined the cooling medium 19, for example, the condensator which supplies cooling water, the tank 20, and the circulating pump 21, and the control operation part 23 which gives a control signal to a condensator 19 and a circulating pump 21, in order to adjust the operating temperature in the vessel.
[0070] In the cell stack 11 equipped with such a configuration now the operating temperature in a vessel For example, when it is set as 80 degrees C, When the temperature which the operating temperature in a vessel measured with the dew-point instrument 18 the circumference of under from 80 degrees C becomes 78 degrees C or less, the control operation part 23 It calculates based on the operating temperature in a vessel, and the measurement temperature of a dew-point instrument 18, the operation signal is given to a condensator 19 and a circulating pump 21, and a condensator 19 and a circulating pump 21 are made to drive. Moreover, when it becomes higher than the operation operating temperature in a vessel, the control operation part 23 gives the operation signal to a condensator 19 and a circulating pump 21, and stops the drive of a condensator 19 and a circulating pump 21.
[0071] As opposed to an operating temperature thus -- this operation gestalt -- the cell stack 11 -- the cooling-medium feeder 22 and the control operation part 23 -- preparing -- vessel inside installation -- a law -- at the time of lower ****** Since evaporation of the water of condensation generated within a vessel was promoted when the water of condensation generated within a vessel was promoted, on the contrary it exceeded to the setting operating temperature in a vessel, the cell output generated from the cell stack 11 can be further heightened compared with the former. Incidentally, according to the experiment, the sag rate was able to be made low 1/3 or less compared with the conventional operating-temperature regularity.
[0072] Drawing 8 is the control schematic diagram showing the 1st modification of the operation gestalt shown in drawing 7 which controls the operating temperature of the cell stack applied to the fuel cell equipment concerning this invention.
[0073] While making it the same as that of the configuration of the operation gestalt shown by drawing 7 , attach the resistance measurement equipment 24 which measures the internal resistance of the unit cell 10 to the cell stack 11, it is made to calculate by the control operation part 23 based on a signal whenever [resistance signal / from resistance measurement equipment 24 /, and vessel internal temperature], and is made to drive the cooling-medium feeder 22 in this example.
[0074] For resistance measurement equipment 24, when the operating temperature in a vessel is set as 80 degrees C, the internal resistance value of the unit cell 10 is 90-ohmcm2. When it becomes above, the cooling-medium feeder 22 is made to drive, the operating temperature of the cell stack 11 is reduced, and it is 90-ohmcm2 conversely. If it becomes below, the drive of the cooling-medium feeder 22 is stopped and it has composition which raises the operating temperature of the cell stack 11.
[0075] Therefore, according to this example, the cell output of the water of condensation generated in a vessel generated from the cell stack 11 since the operating temperature of the cell stack 11 is somewhat controllable according to an amount can be further heightened compared with the former.
[0076] In addition, although resistance measurement equipment 24 was attached to the cell stack 11, load current 25 [a total of] may be attached to the cell stack 11, it may be made to calculate by the control operation part 23 based on a signal whenever [from the current signal, the signal from Humidifiers 17a and 17b, and thermometer 26 from load current 25 / a total of / vessel internal temperature], and the cooling-medium feeder 22 may be made to drive in this example, as shown in drawing 9 .
[0077]
[Effect of the Invention] Since reactant gas is beforehand humidified corresponding to the operating temperature of the cell stack passed first while elevated-temperature-izing relatively [flow direction / of reactant gas] one by one the operating temperature of the cell stack which the fuel cell equipment concerning

this invention connected the cell stack to series, and was connected to series as the above explanation, the reaction specific consumption of reactant gas can be raised and the stable cell output can be generated.
[0078] Moreover, while elevated-temperature-izing relatively [flow direction / of reactant gas] one by one the operating temperature of the cell stack which the fuel cell equipment concerning this invention connected the cell stack to series, and was connected to series Since it had a cooling-medium supply means to pour a cooling medium in the same direction as the flow direction of reactant gas and temperature inclination-ization of each cell stack was attained while making reactant gas humidify beforehand corresponding to the operating temperature of the cell stack passed first The cell output which was made to promote evaporation of the water of condensation generated, and was stabilized can be generated in the case of the reaction of oxidant gas.
[0079] Moreover, while elevated-temperature-izing relatively [flow direction / of reactant gas] one by one the operating temperature of the cell stack which the fuel cell equipment concerning this invention connected the cell stack to series, and was connected to series While dividing at least one or more cell stacks elevated-temperature-ized relatively one by one to the sub cell stack elevated-temperature-ized still more relatively [flow direction / of reactant gas] one by one Since reactant gas is beforehand humidified corresponding to the operating temperature of the sub cell stack passed first, the reaction specific consumption of reactant gas can be raised further, and the stable cell output can be generated.
[0080] Moreover, since the reactant gas passed to the elevated-temperature-ized cell stack was made the configuration which can be passed in any direction of right reverse while elevated-temperature-izing relatively [flow direction / of reactant gas] one by one the operating temperature of the cell stack which the fuel cell equipment concerning this invention connected the cell stack to series, and was connected to series, generating of the stable cell output can be maintained for a long time.
[0081] Moreover, since the fuel cell equipment concerning this invention was made the configuration which prepares a header in the both ends of a separate reactant gas supply slot, and can supply more reactant gas, it can generate a still higher cell output under the structure made to simplify.
[0082] Moreover, since the fuel cell equipment concerning this invention established the control system which controls the cooling-medium feeder which adjusts the operating temperature of a cell stack, and a cooling-medium feeder, it can be adjusted to the desirable amount of water which made the water of condensation generated by the cell stack correspond to operational status.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The block diagram showing the 1st operation gestalt of the fuel cell equipment concerning this invention.
[Drawing 2] The mimetic diagram showing the 2nd operation gestalt of the fuel cell equipment concerning this invention.
[Drawing 3] The mimetic diagram showing the 3rd operation gestalt of the fuel cell equipment concerning this invention.
[Drawing 4] The mimetic diagram showing the 4th operation gestalt of the fuel cell equipment concerning this invention.
[Drawing 5] The mimetic diagram showing the 5th operation gestalt of the fuel cell equipment concerning this invention.
[Drawing 6] The schematic diagram showing the operation gestalt of the separator applied to the fuel cell equipment concerning this invention.
[Drawing 7] The outline control schematic diagram showing the operation gestalt which controls the operating temperature of the cell stack applied to the fuel cell equipment concerning this invention.
[Drawing 8] The outline control schematic diagram showing the 1st modification in the operation gestalt which controls the operating temperature of the cell stack applied to the fuel cell equipment concerning this invention.
[Drawing 9] The outline control schematic diagram showing the 2nd modification in the operation gestalt which controls the operating temperature of the cell stack applied to the fuel cell equipment concerning this invention.
[Drawing 10] The mimetic diagram showing the unit cell in conventional fuel cell equipment.
[Description of Notations]
1 Solid-state Polyelectrolyte Film
2 Anode Electrode
2a Anode catalyst bed
2b Anode porosity carbon plate
3 Cathode Electrode
3a Cathode catalyst bed
3b Cathode porosity carbon plate
4 Ten Unit cell
5a Fuel gas supply slot
5b Oxidant gas supply slot
6 Seven Separator
6a, 7a Partition
8 Cell Stack
10 Unit Cell
11 Cell Stack
11a The cell stack for low-temperature operation
Elevena1, 11b1, 11c1 Sub cell stack for low-temperature operation
11b The cell stack for moderate temperature operation
Elevena2, 11b2, 11c2 Sub cell stack for moderate temperature operation
11c The cell stack for elevated-temperature operation

Elevena3, 11b3, 11c3 Sub cell stack for elevated-temperature operation
12 Cooling Water Supply Means
13 Separator
14 Reactant Gas Supply Slot
15 Inlet-Port Header
15a Inlet-port manifold
16 Outlet Header
16a Outlet manifold
17a, 17b Humidifier
18 Dew-point Instrument
19 Condensator
20 Tank
21 Circulating Pump
22 Cooling-Medium Feeder
23 Control Operation Part
24 Resistance Measurement Equipment
25 Load Current Meter
26 Thermometer

[Translation done.]

* NOTICES *

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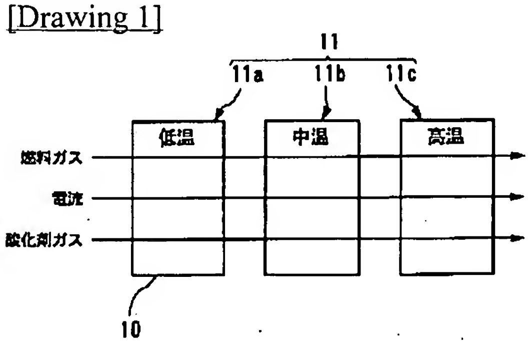
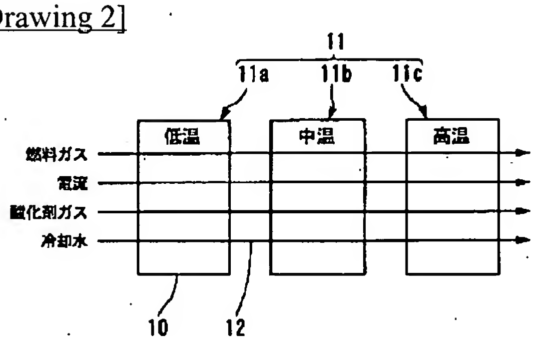
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

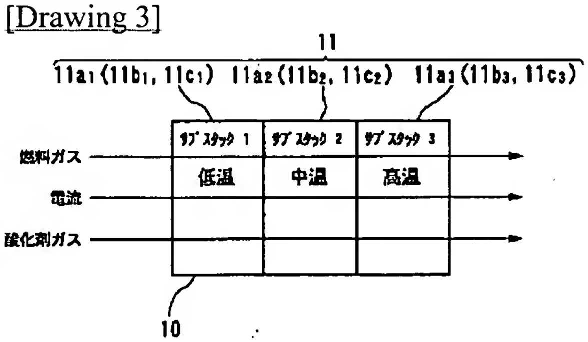
[Drawing 1]



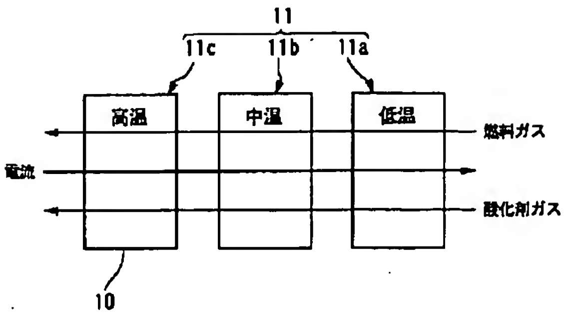
[Drawing 2]



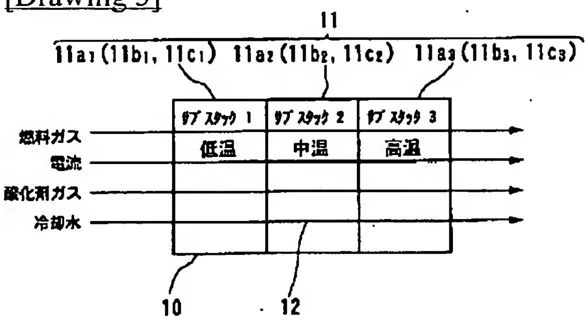
[Drawing 3]



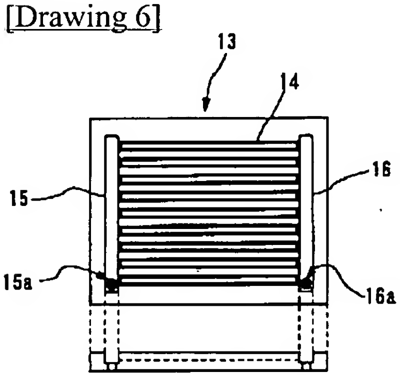
[Drawing 4]



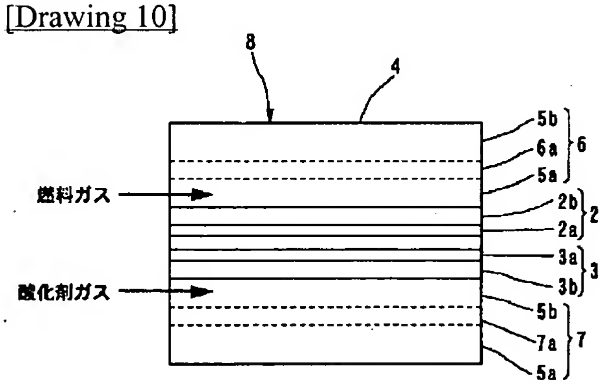
[Drawing 5]



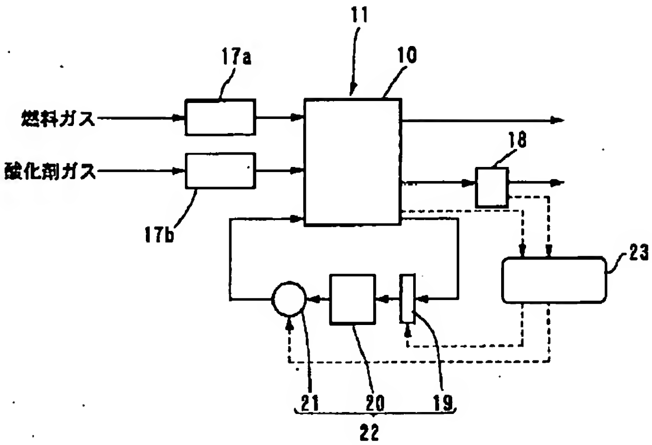
[Drawing 6]



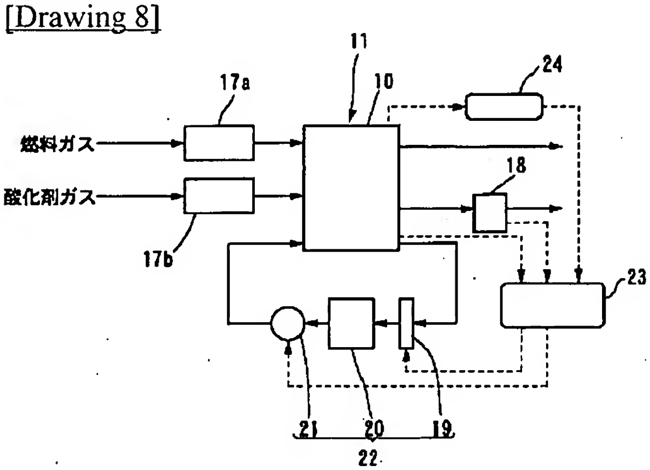
[Drawing 10]



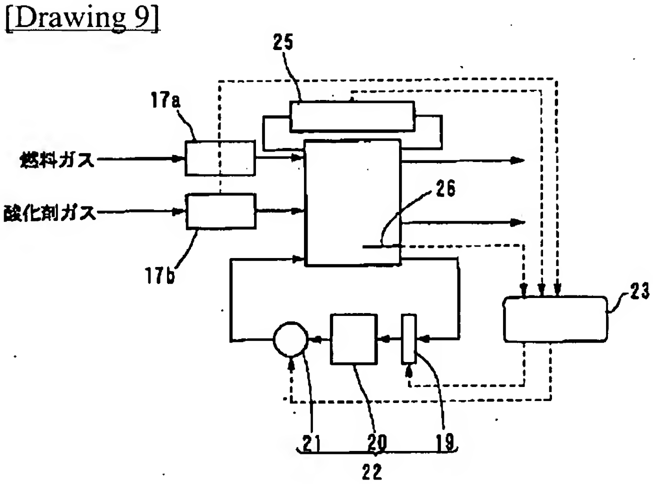
[Drawing 7]



[Drawing 8]



[Drawing 9]



[Translation done.]